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The Effect of Active-Participant Experiments upon the Skills of Nursery Class Students to Recognize Measuring Instruments

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Abstract

Preschool children learn through their senses. Children learn language, daily life skills, concepts and many other things through their senses. Thus, preschool educational environments and preschool educational activities should stimulate children's senses. In this context, preschool science activities and experiments have positive effects upon children's development and learning as they contain skills aimed at various senses like observation, relationship establishment, interpretation, inference and discussion. The objective of this study is to determine the effect of active-participant experiments upon the skills of preschool children to recognize and accurately select measuring instruments that are encountered in daily life and used in measuring various magnitudes. In the study, action research method was used. The study was conducted in the school year of 2015-2016 with totally 19 children (8 male and 11 female) aged 48-60 months. A total of 6 experiments (mass, weight, volume, length, temperature and time) were performed in 3 weeks to measure two magnitudes each week. In order to collect the study data, the researchers developed a measuring instrument of totally 6 questions, 3 of which were distracting. As a result of the study, it was determined that the experiments were effective upon the skills of children to recognize and accurately select measuring instruments that were used in measuring daily life magnitudes like mass, weight, volume, length, temperature and time.

Introduction

Preschool period is the second period where development is the fastest after prenatal period in human life. In periods where development is fast, learning is fast as well. In the preschool period, children mainly learn through their senses and acquire abundant knowledge and skills through their senses. In the first years of life, children seek and try to learn knowledge and skills to use in their future life. Jean Piaget defines children as little scientists that try to explore the world. The quest of children in the learning process can only be responded by an environment that is rich in stimulus. A quality preschool educational environment and quality preschool educational activities will provide the stimulus needed by children in the learning process. The development of young children is realized through their experiences in centers like school and home within micro systems (Bronfenbrenner and Morris, 2006). Children begin to investigate and explore their environment as from the first years of life (California Department of Education, 2013) and they have the skills of comprehending and learning knowledge in scientific fields like life science, location science and physical science at an early age (Erden and Sönmez, 2011; National Association for the Education of Young Children, 2014). However, the preschoolers sometimes overgeneralize (Kabadayı, 2006) the objects and sometimes over regularize (Kabadayı, 2012) them in their responses in different categories, while object labeling process in their environment. The study results show that preschool children can think about science and use scientific knowledge by making comparisons and estimations (Carey 2009; National Research Council, 2007; Schulz and Bonawitz, 2007).

Free researches and experiments conducted in the first two years of life will enable the development of children's senses (Charlesworth and Lind, 2003). Children's natural behaviors in these years will increase their interest in science in the future. Rich stimulus experiences (seeing, hearing, tasting, touching, and smelling) allow children to become better observers and more curious individuals (Akman, Üstün and Güler, 2003). It is believed that children can explore scientific knowledge and skills only in a free environment (Sundberg and Ottander, 2014).

Gelman, Brenneman, Macdonald, and Roman (2009) collect scientific applications aimed at preschool children under five titles as; 1) observation, prediction, control, 2) comparison, opposition, experiment, 3) word, discussion and language, 4) accounting, measuring and math's and 5) record and documentation.

Rather than directly conveying scientific knowledge to children; preschool science education aims to allow them to learn these knowledge by experiencing and practicing (Aktaş-Arnas, 2002). Science education allows children to understand and learn their environment. With the help of science activities, children develop their learning skills, explore, obtain information about scientific methods like measuring, learn scientific language and special signs, conduct and explain experiments and participate in discussions (Curriculum For Excellence, 2004: 253; Dere and Ömeroğlu, 2001). Experiments play an important role in preschool science education activities. Experiments that are conducted in preschool education classes allow children to materialize abstract concepts and develop positive attitudes toward science (Alisinanoğlu, Özbey and Kahveci, 2011). Preschool children can learn more easily through concrete ways. Experiments are necessary for materializing abstract scientific concepts that children desire to investigate (Kandır et al., 2012). Children acquire not only scientific knowledge, but also scientific process skills with the help of experiments that are conducted in preschool science activities. From the middle of the 20th century, inclusion of all scientific process skills in science education programs has become important (Erten, Kiray and Sen-Gumus, 2013). Scientific process skills of preschool children include; observation, measuring, comparison, classification and communication (Alisinanoğlu, Özbey and Kahveci, 2007:14; Charlesworth and Lind, 2003; Kandır, Can Yaşar, İnal, et al., 2012:17; Keil, Haney and Zoffel, 2009). Choi (2016) explains the science learning of preschool children as in Figure 1.

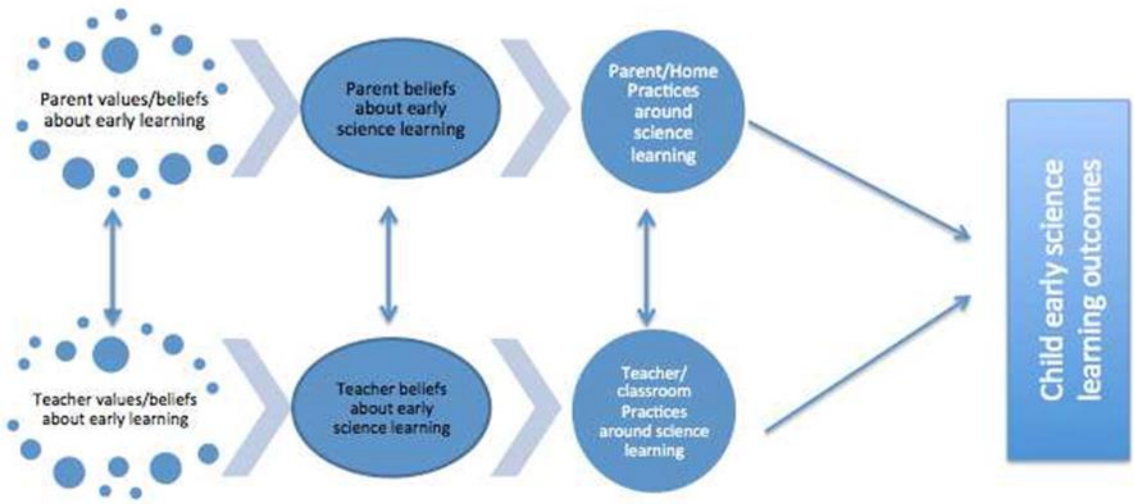


Figure 1. Children's development of early science learning (Source, Choi, 2016)

Being one of scientific process skills; measuring is defined as making qualitative and quantitative distinctions between objects and features via an measuring instrument (TDK, 2016). Measuring, in the most general sense, is a comparison and accounting and it contains the use of standard and non-standard units for defining measurable qualities like linear dimensions, area, volume, time, temperature and mass. Children can measure the length of a table, extent or width of a room, height of a door, their own length and a lot of things in their physical environment. (Martin, 2011: 87). Measuring skill allows preschool children to solve many daily life problems that require this skill. Thus, it is important for children to acquire this skill at a early age. Examining the studies on preschool science education in literature; it is seen that the studies focus on methods and techniques being used by preschool teachers in science education (Ayvacı, Devecioğlu and Yiğit, 2002; Güler and Bıkmaz, 2002; Karaer and Kösterelioğlu, 2005; Taş, 2010), content of preschool science education (Brunton and Thornton, 2010), competence of preschool teachers in science education (Karamustafaoğlu and Kandaz, 2006; Özbey, 2009), attitudes of preschool teachers toward science education (Kallery, 2004; Ünal and Akman, 2006), role of teachers in science education (Martin et al., 2005), awareness of teachers (Chang, 2012), teachers' sense of science (Saçkes et al., 2009) and children's exploration of the properties of water (Siri, Ziegler and Max, 2012). The study results also show that preschool children and their teachers do not spare enough time for science activities (Early et al., 2010). Relevant literature does not include any studies aimed at the skills of preschool

children to recognize and select measuring instruments that are used in measuring various magnitudes via active-participant experiments. Thus, both the study and its potential results are considered important.

Study Objectıve

The objective of this study is to determine the effect of active-participant experiments upon the skills of preschool children (aged 48-60 months) to recognize and accurately select measuring instruments (meter, equal arm balance, dynamometer, graduated cylinder, thermometer and chronometer) that are encountered in daily life and used in measuring various magnitudes (length, mass, weight, volume, temperature, time).

Method

Action research, one of the qualitative research methods, was used in the study. Action research is suitable for the individuals who are directly related to the process to be developed and it can also be used to solve the professional problems a person meet in his field of expertise or to increase the quality of the work he does (Büyüköztürk, et. al., 2010). It was thought in the study conducted that the use of this method was suitable to determine the effect of active-participant experiments upon the skills of preschool children (aged 48-60 months) to recognize and accurately select measuring instruments that are encountered in daily life and used in measuring various magnitudes. Table 1 shows the study pattern.

Table 1**.** Study Pattern

Groups	Pretest	Procedure	Posttest	Permanence test
Experiment	Informational questions	Experimental study (3 weeks)	Informational questions	Informational questions (5 weeks later)

Procedure

1. Week: Visual measuring instrument of totally 6 questions, 3 of which were distracting, aimed at determining whether or not children were able to recognize appropriate measuring instruments used in measuring various magnitudes like mass, weight, volume, length, temperature and time in daily life was displayed for children by using a projector and a projection curtain and children were individually asked to answer the questions. Answers given by children to the questions were recorded by the researcher in writing. The process lasted for approximately 8 minutes for each child.

2. Week: In the experimental procedure stage, 2 different experiments were prepared for introducing equal arm balance, which is used measuring the mass, and dynamometer, which is used in measuring weight, and the experiments were applied with active participation of children. Each experiment lasted for approximately 35 minutes.

3. Week: The experimental procedure was sustained and 2 different experiments were prepared for introducing meter, which is used in measuring length, and chronometer, which is used in measuring time, and the experiments were applied with active participation of children. Each experiment lasted for approximately 30 minutes.

4. Week: In this final week of the experimental procedure, 2 different experiments were prepared for introducing thermometer, which is used in measuring temperature, and graduated cylinder, which is used in measuring volume, and the experiments were applied with active participation of children. Each experiment lasted for approximately 35 minutes.

5. Week: The measuring instrument that was applied in the 1st week after completing the experimental procedure was reapplied to children as a posttest in the computer environment. In that process, children individually answered the questions that were mirrored by computer and projection. Their answers were recorded by the researcher. The process lasted for approximately 7 minutes for each child.

10. Week: 5 weeks after the application of the posttest, the same measuring instrument was reapplied to children as a permanence test in the computer environment. Children individually answered the questions that were

mirrored by computer and projection. Their answers were recorded by the researcher. The process lasted for approximately 7 minutes for each child.

Working Group

Working group of the study was determined by using the technique of typical case sampling, which is among purposeful sampling methods. Typical case sampling is among the purposeful sampling methods used for determining the sample group in qualitative researches. In typical case sampling, it is aimed to have an opinion about a particular field by studying average conditions (Yıldırım and Şimşek, 2008). The study included totally 19 children (8 male and 11 female) aged 48-60 months, who were thought to show similar features to other children in this age group. All children in the working group showed a normal development.

Data Collection Tool

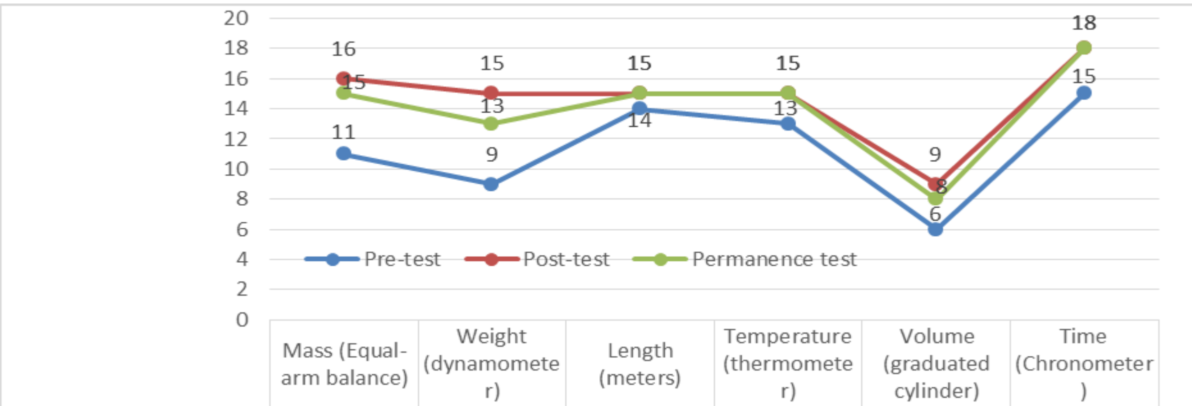
In order to collect the study data, the researchers developed a visual measuring instrument of totally 6 questions, 3 of which were distracting, aimed at determining whether or not children were able to recognize appropriate measuring instruments used in measuring various magnitudes like mass, weight, volume, length, temperature and time in daily life. The measuring instrument was developed based on the opinions of 2 preschool teachers and 3 academicians. In this context, the visual measuring instrument involved 6 questions aimed at using appropriate measuring instruments in measuring these concepts encountered in daily life and popular cartoon characters for children **(Appendix 1).** The visual measuring instrument was displayed for children using a projector and a projection curtain and children were individually asked to answer the questions. Answers given by children to the questions and their reasons were recorded by the researcher in writing.

Data Analysis

Statistical analyses of the data that were collected for sub-problems, which were tried to be answered within the frame of the general study objective, were conducted by using frequency. Numerical data were interpreted in graphics. Besides, opinions of children about measuring instruments were conveyed without making any changes.

Findings

Diagram 1 shows the data concerning the state of preschool children (aged 48-60 months) to recognize and select measuring instruments used in measuring various magnitudes that are encountered in daily life.



	Mass (Equal-arm balance)	Weight (dynamometer)	Length (meters)	Temperature (thermometer)	Volume (graduated cylinder)	Time (Chronometer)
Pre-test	11	9	14	13	6	15
Post-test	16	15	15	15	9	18
Permanence test	15	13	15	15	8	18

Diagram 1. Distribution of Preschool Children (Aged 48-60 Months) to Recognize and Select Measuring Instruments Used in Measuring the Magnitudes of Mass, Weight, Length, Temperature, Volume and Time (f)

Examining Diagram 1; 11 children responded “right” and 8 children responded “wrong” to the question, “mass should be measured with equal-arm balance” in the pretest. However, at the end of the experimental study, it was observed that 16 children responded “right” and 3 children responded “wrong” to this question. In the permanence test, 15 children responded “right” and 4 children responded “wrong”. Similarly, 9 children responded “right” and 10 children responded “wrong” to the question, “weight should be measured with dynamometer” in the pretest. However, at the end of the experimental study, it was observed that 15 children responded “right” and 4 children responded “wrong” to this question. In the permanence test, 13 children responded “right” and 6 children responded “wrong”. 14 children responded “right” and 5 children responded “wrong” to the question, “length should be measured with meter” in the pretest. However, at the end of the experimental study, it was observed that 15 responded “right” and 4 children responded “wrong” to this question. In the permanence test, the posttest scores remained the same. 13 children responded “right” and 6 children responded “wrong” to the question, “temperature should be measured with thermometer” in the pretest. However, at the end of the experimental study, it was observed that 15 children responded “right” and 4 children responded “wrong” to this question. In the permanence test, the posttest scores remained the same. 6 children responded “right” and 13 children responded “wrong” to the question, “volume should be measured with graduated cylinder” in the pretest. However, at the end of the experimental study, it was observed that 9 children responded “right” and 10 children responded “wrong” to this question. In the permanence test, 8 children responded “right” and 11 children responded “wrong”. Finally, 15 children responded “right” and 4 children responded “wrong” to the question, “time should be measured with chronometer” in the pretest. However, at the end of the experimental study, it was observed that 18 children responded “right” and only 1 child responded “wrong” to this question. In the permanence test, the posttest scores remained the same.

Examining Diagram 1; it was observed that children had preliminary information mainly about the necessity for measuring time with chronometer (f=15), which was followed by the necessity for measuring length with meter (f=14), temperature with thermometer (f=13), mass with equal-arm balance (f=11) and weight with dynamometer (f=9). On the other hand, children had minimum preliminary information about the necessity for measuring volume with graduated cylinder (f=6). However, as a result of the experimental study, an increase was observed in the rate of children to recognize and accurately select appropriate measuring instruments in measuring these concepts. In this context, 18 children stated, “time should be measured with chronometer”, 16 children stated, “mass should be measured with equal-arm balance” and 15 children individually stated, “weight should be measured with dynamometer, temperature with thermometer and length with meter” in the posttest. 9 children also stated, “volume should be measured with graduated cylinder”. As a result of the permanence test, there was a decrease at the least and it was determined that children continued to recognize and accurately select appropriate measuring instruments in measuring these concepts. In this context, 18 children stated, “time should be measured with chronometer”, 15 children individually stated, “mass should be measured with equal-arm balance, temperature with thermometer and length with meter”, 13 children stated, “weight should be measured with dynamometer” and 8 children stated, “volume should be measured with graduated cylinder” in the permanence test. Table 2 shows the opinions of preschool children (aged 48-60 months) about their state of recognizing and selecting measuring instruments that are used in measuring various magnitudes encountered in daily life.

Conclusion

The study results reveal that experiments being conducted are effective upon preschool children (aged 48-60 months) to recognize and accurately select measuring instruments used in measuring various magnitudes like mass, weight, length, temperature, volume and time that are encountered in daily life. In this context, it is seen that children’s active participation in experiments under the guidance of teachers provides an opportunity for permanent learning. Experiments are among basic learning methods in science education (Yıldız, Aydoğdu, Akpınar and Ergin, 2006:72). Experiments can be performed on many different topics in preschool education classes and these experiments will allow children to materialize abstract concepts (Alisinanoğlu et al., 2011; Kandır et al., 2012; Uyanık Balat and Önkol, 2010). Teachers have a tendency to show children scientific facts via experiments and science activities and they frequently apply to experiments in science activities (Merino et al., 2014; Özbek, 2009). Fleer (2013) suggests that teachers realize science education via counseling, material procurement, discussion or experiments. Preschool teachers primarily use scientific experiments and activities for the purpose of showing children the world (Choi, 2016).

The study results reveal that children have preliminary information mainly about the necessity for measuring time with chronometer, length with meter and temperature with thermometer, which is associated with the fact that they encounter all three measuring instruments very frequently in daily life. On the other hand, children

have minimum preliminary information about the necessity for measuring volume with graduated cylinder and weight with dynamometer, which is associated with their inability to recognize these measuring instruments or perceive what they measure.

Table 2. Opinions of Preschool Children (Aged 48-60 Months) about Their State of Recognizing and Selecting Measuring Instruments That are Used in Measuring Various Magnitudes Encountered in Daily Life

Concepts	Code	Pre-test	Post-test	Permanence test
Mass	K_4	**Answer:** Equal arm balance (✓) It will lift as it can scale anything.	**Answer:** Equal arm balance (✓) It is called balance. It has two plates; the light one rises whereas the heavy one descends just like a teeter totter.	**Answer:** Equal arm balance (✓) It measures with balance.
	E_1	**Answer:** Thermometer (X) Because it has numbers on it.	**Answer:** Equal arm balance (✓) Because it contains two sacs.	**Answer:** Equal arm balance (✓) Because it is balance.
	E_8	**Answer:** N/A (X) I do not know.	**Answer:** Equal arm balance (✓) Because it is balance.	**Answer:** Equal arm balance (✓) It puts them in sacs.
Weight	E_2	**Answer:** Meter (X) To measure the length of the basket.	**Answer:** Dynamometer (✓) The weighbridge rises when a weight is put on the hook. The hook perceives the heavy one.	**Answer:** Dynamometer (✓) Because it measures the weight of anything.
	K6	**Answer:** N/A (X) I do not know.	**Answer:** Dynamometer (✓) It measures the weights with a hook.	**Answer:** Dynamometer (✓) I forgot what it is called, but it is measured with it. Because others can not measure it.
	E5	**Answer:** Equal arm balance (X) It puts the apples in the basket and measures them.	**Answer:** Dynamometer (✓) It squeezes the apples in its hook. The basket rises when it is hung.	**Answer:** Dynamometer (✓) Because weight is measured with it. The hook is put on the basket.
	E8	**Answer:** N/A (X) I do not know	**Answer:** Dynamometer (✓)	**Answer:** Dynamometer (✓)
Length	K11	**Answer:** Meter (✓) Because that's what measures the length.	**Answer:** Meter (✓) Because it is meter. It measures lengths.	**Answer:** Meter (✓) My mother always measures my length with it.
	E4	**Answer:** Meter (✓) Because it's a length scale.	**Answer:** Meter (✓) We can measure it with meter. We used to measure length with it.	**Answer:** Meter (✓) Meter needs to be used. Because we measured with it.
	E6	**Answer:** Meter (✓) It puts them on and measures them.	**Answer:** Meter (✓) I forgot what it is called. It steps on your foot and remains like that.	**Answer:** Meter (✓) Because it measures according to your length.
	K6	**Answer:** N/A (X) I do not know.	**Answer:** Meter (✓) We used it for measuring length.	**Answer:** Meter (✓) It measures with meter.
Temperature	E4	**Answer:** Thermometer (✓) Because it can measure the temperature of water.	**Answer:** Thermometer (✓) Thermometer measures. Because the red sign moves in the heat.	**Answer:** Thermometer (✓) Because temperature of water can be measured with thermometer. The red sign either rises or descends.
	K11	**Answer:** Thermometer (✓) Because it feels the temperature.	**Answer:** Thermometer (✓) It is called thermometer. We put it in water.	**Answer:** Thermometer (✓) I forgot what it is called, but it puts things in water and measures..
Volume	K9	**Answer:** N/A (X) I do not know.	**Answer:** Thermometer (✓) It had risen when we put it in hot water and descended when we put it in cold water.	**Answer:** Thermometer (✓) Because hot water rises the red sign.
	K6	**Answer:** N/A (X) I do not know.	**Answer:** Graduated cylinder (✓) It throws the rocks inside and measures them.	**Answer:** Graduated cylinder (✓) I forgot what it is called, but that's it.
	E4	**Answer:** Equal arm balance (X) It can be measured with a scale	**Answer:** Graduated cylinder (✓) Because it is called scale.	**Answer:** Graduated cylinder (✓) We have one in our kitchen at home and we measure with it.
	E6	**Answer:** Equal arm balance (X) It puts one marble in one sac and another marble in another sac and measures them.	**Answer:** N/A (X) I do not know.	**Answer:** Microscope (X) It throws the marble in it and observes via its glass.
Time	E1	**Answer:** Chronometer (✓) Because there are inscriptions.	**Answer:** Chronometer (✓) Because there are inscriptions.	**Answer:** Chronometer (✓) Because there are numbers in it.
	K6	**Answer:** N/A (X) I do not know.	**Answer:** Chronometer (✓) It could be the other one as the two are not the answer.	**Answer:** Chronometer (✓) It is measured with it as the others can not.
	E4	**Answer:** Chronometer (✓) Only the one that resembles a watch can measure.	**Answer:** Chronometer (✓) Others measure temperature and another one is used in repairing.	**Answer:** Chronometer (✓) It is held in one hand to count the time.

The study results show that children make information obtained from active-participant experiments meaningful by associating them with daily life. For instance, the child coded E4 responded “equal arm balance” in the pretest and “graduated cylinder” in the posttest and the permanence test to the question, “What measuring instrument should measure volume”. The child explained his reason for selecting the option in the permanence test as, “We have one in our kitchen at home and we measure with it.” This answer proves that children make information obtained from experiments meaningful by associating them with daily life. Studies suggest that active-participant experiments conducted by children become more meaningful when they are associated with daily life. In their experiments, children may make generalizations on the basis of simple results (Şahin, 2000). Experiments help young children distinguish certain and uncertain information (Piekny and Maehler, 2013). Preschool teachers believe that activities like experiment, observation and estimation develop children’s scientific skills (Maier et al., 2013). Experimental activities at playschools allow children to comprehend oppositions and differences between various situations (Andersson and Gullberg, 2014).

The study results also reveal that the greatest increase in correct answers is observed in the necessity for measuring weight with dynamometer. While the number of children who gave correct answers in the pretest was 9; this number rose to 15 in the posttest. The minimum increase was observed in the necessity for measuring length with meter. In this context, while the number of children who gave correct answers to this question in the pretest was 14; this number rose to 15 in the posttest.

Recommendations

As a consequence, this study reveals that active-participant experiments conducted by preschool children are effective upon the skills of children to recognize measuring instruments and produce permanent results. In this context, the following recommendations are made.

- Science activities play an important role for preschool children to explore their world. Thus, preschool educational environments should be supported by science materials.
- Competence of preschool teachers concerning science education activities should be increased and vocational training opportunities should be given to teachers on this subject.
- Science education activities should be involved more in preschool curriculums.
- Parents should be supported for home-centered science education activities and for acquiring knowledge and skills on this subject.
- Social awareness should be increased by organizing scientific activities like conference, congress and workshop aimed at preschool science activities.
- Other scientific process skills of children should be investigated via active-participant experiments.

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Appendix 1. Sample Questions about Measuring Instruments

Keloğlan wants to measure the weight of the apples he had bought from the market place. Which of the following measuring instruments should he use?

Tom burns the oven to boil water and the water starts boiling. Which of the following measuring instruments can measure the temperature of the boiling water?